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Networking for resources: how regulators use networks to compensate for lower staff numbers.

Abstract

The literature has found that regulatory networks foster exchange of information between regulators, but failed to specify the mechanism whereby regulators network for expertise. This paper posits that informal networks constitute a compensatory mechanism for lacking resources. The hypothesis guiding analysis is that lower resources (operationalized as staff resources) are associated with higher network activism (operationalized as a higher proportion of outgoing ties), particularly for regulators with intermediate levels of resources, for whom the benefits of networking are most likely to outweigh the costs. I test this hypothesis in the empirical case of European national energy regulators, using recent and original data on their bilateral collaboration ties. The results of the statistical analysis lend support to the hypothesis. The results suggest that the interdependence engendered by the European Union improves European regulatory governance by improving national regulatory practice, more than would be possible on the basis of national resources alone.

Keywords: Expertise, Learning, Network activism, Regulatory networks, Resources

Introduction

The scholarly debate on networks of European regulators has long revolved around functional versus intergovernmental explanations of their establishment. Recently, however, there have been calls (Mastenbroek and Martinsen 2018) and attempts (Boeger and Corkin 2017; Maggetti 2014; Ruffing 2014) to shift scholarly attention from debating the preferences of the European Commission and the Member States regarding the purpose of regulatory networks to studying the ways in which regulators concretely use their informal networks. This paper contributes to this unfolding strand of inquiry by investigating the relationship between the resources available to a regulatory authority and its networking behaviour. In doing so, the paper understands regulatory networks as resources in themselves, and puts forward the hypothesis that regulators rely on informal networking in order to compensate for their scarce resources.

Initial hopes that networks would engender regulatory convergence across the European Union (EU) have been downsized, given network's mixed record in achieving EU-wide rule adoption in different sectors (Maggetti 2014; Maggetti and Gilardi 2014; Bach et al. 2016). Recent contributions have focused on the strategic usage that regulators make of their networks. They found that network participation increases bureaucratic autonomy (Danielsen and Yesilkagit 2014), as networks provide regulators with information that is not available to their national principals. Other contributions have showed that participation into networks correlates with increased powers (Maggetti 2014), and facilitates the sharing of existing resources and the creation of new ones as outputs of network collaboration (Vestlund 2015).

The topic of regulators' resources has often surfaced in the relevant literature, but has rarely been tackled in its own merit. Yet, resource constraints significantly affect regulatory performance, pushing regulators to optimize the resources they have in the face of increasing

sector complexity (Glachant et al. 2013). Higher staff resources have been found to increase the quality of regulation (Koop and Hanretty 2017). Hence, whereas well-resourced regulators are likely to possess sufficient expertise, less well-resourced regulators may struggle to accomplish their tasks.

The resources available to a regulatory authority positively correlate to country and market size, suggesting that regulators from smaller countries need lower resources to begin with. However, all regulatory authorities need to fulfil a set range of expert tasks, whatever their size (Glachant et al. 2013). In order to fulfil their tasks, less resourced regulatory authorities may recur to the extra resources they have available, such as their peers.

The hypothesis driving this analysis is that lower resources are associated with higher network activism, particularly at intermediate levels of resources. Indeed, the possession of network ties entails costs, besides benefits (Jackson 2008). For highly constrained regulatory authorities, the benefits of networking may not outweigh the costs. Well-resourced regulatory authorities should possess sufficient in-house expertise not to need to network extensively. Regulators with intermediate resources stand to benefit most from informal networking: they have lower resources than they need, but are not overly constrained.

I test this hypothesis in the empirical case of the network of informal bilateral relationships linking national energy regulatory authorities of the European Union. The data derives from a questionnaire I submitted to regulators between September 2015 and March 2016. The questionnaire asked regulators a single question: to name the regulatory authorities with which they have most frequent contact as concerns exchange of information, opinions and knowledge. I obtained data on outgoing ties from each of the 29 European energy regulatory authorities (i.e. one from each EU Member State plus Norway), bar one. For that regulator, I considered their incoming ties as reciprocated.

The dependent variable used in this analysis is defined as 'network activism'. It is operationalized as the difference between regulators' incoming and outgoing non-mutual ties in the directed network resulting from their frequent bilateral exchanges of information. In other words, I use regulators' 'weak ties' (Granovetter 1973) as the dependent variable in order to capture regulators' effort in seeking information from their network.

As independent variable, I use categorical data on staff resources dedicated to energy regulation released in 2016 by the Agency for the Cooperation of Energy Regulators (ACER). Exploratory data analysis followed by linear regression and Exponential Random Graph Models (ERGMs) lend support to the hypothesised mechanism. Regulators with intermediate staff levels appear more active than their counterparts. This suggests rationality: regulators are active only if the benefits of networking outweigh the costs.

As covariates, I use indicators of regulators' statutory independence and the liberalisation of their national markets: both correlate with network activism, but in different ways and differently across electricity and gas. In accordance with expectations, regulators appear most active at intermediate levels of independence. The relationship with liberalisation levels is less clear. Overall, lower liberalisation dampens activism; however, regulators with medium resources appear more active at higher levels of liberalisation.

To understand whether networks can improve governance, it is important to study how regulators use them. This analysis suggests that regulators use their bilateral network ties to compensate for their lacking resources. Existing theory suggests that reputation is extremely important for regulatory authorities (Carpenter 2004; Busuioc 2016; Busuioc and Lodge 2016). Regulatory reputation relies on regulators' expertise (Schrefler 2010). This analysis shows that regulators use networks to improve their expertise when faced with scarce resources. This leads to improving their reputation nationally and at European level. Arguably, European energy

regulators' common embeddedness in the European Union underlies this mechanism. Absent that interdependence, well resourced regulators would hardly network with less resourced peers, as they benefit less from the exchange. Finally, the results of this analysis suggest that, if European regulatory networks may have uneven influence on regulatory convergence, they probably have a consistent impact on improving European regulatory policy and practice via the national level.

2. Theoretical background and hypotheses.

One of the key questions in the literature on regulatory networks, particularly in the European Union, concerns the extent to which they are able to improve governance (Coen and Thatcher 2008; Levi-Faur 2011; Maggetti and Gilardi 2011; Thatcher 2011; Kelemen and Tarrant 2011; Van Boetzelaer and Princen 2012; Maggetti and Gilardi 2014; Blauberger and Rittberger 2015).

The literature has considered collaboration and exchanges of information between European national regulatory authorities as almost obvious: the vagueness of the European Directives, which bind Member States to goals but not to means, renders the pursuit of regulatory convergence necessary (Nicolaides 2004; Dehousse 1997; Eberlein and Grande 2005). Until recently, this focus has been predominant. Therefore, assessments of regulatory networks have often attempted to capture their impact on regulatory convergence, which has, however, proven hard to discern (Bach et al. 2016).

Mere participation into networks, however, reveals nothing of how individual regulators use them (Bach and Newman 2014; Ahdieh 2015). Therefore, this paper does not study European regulatory networks as organisations established by the European Commission within the

context of European market integration; rather, it studies the informal, voluntary, bilateral ties that regulators maintain with the precise intent of consulting each other on matters of their national regulatory practice. This is a prominent gap in this literature (Mastenbroek and Martinsen 2018).

Recently, the literature has begun filling this gap. The relevant contributions have emphasised that networking has the effect of enhancing the *de facto* autonomy of regulators (Danielsen and Yesilkagit 2014; Maggetti and Verhoest 2014; Yesilkagit 2011; Ruffing 2014; Thatcher 2011). Other recent literature has maintained that regulatory networks may improve governance by affording regulators access to high quality information and expertise held by their peers (Bianculli, Jordana, and Juanatey 2015; Jordana 2017; Papadopoulos 2017). However, this literature has failed to specify the mechanism whereby regulators network for expertise.

Contributors have often mentioned the importance of adequate resources for regulators (Maggetti and Gilardi 2014; Coen and Thatcher 2008) but rarely connected them to their networking practices. Existing contributions touch upon the issue only tangentially. For example, Maggetti (2014) investigated the hypothesis that participation in European Regulatory Networks correlated with an increase in the budgetary resources made available to national regulators. He found no support for his hypothesis. Vestlund (2015) explores the connection between networks and resources: in her contribution, networks are producer of resources, i.e. reports, meetings and work plans. In contrast, this contribution focuses on the resources that the regulatory authority needs in order to perform its duties.

The primary duties and powers of national regulatory authorities refer to their national markets. In point of fact, national regulators only possess statutory decision-making authority in their national jurisdictions. In the EU, regulators' national obligations are intertwined with the goals of the European regulatory policy. The aim of the European energy policy is creating an

Internal Energy Market premised on wholesale and retail competition as well as third party access to infrastructures. National regulators have to coordinate to further these goals. Until 2011, they did so informally within the Council of European Energy Regulators (CEER), a regulator-only informal network, which still exists, and the European Regulators' Group for Electricity and Gas (ERGEG), a regulators-Commission network which was terminated upon the creation of the European Agency for the Coordination of Energy Regulators (ACER). Since 2011, regulators tackle issues that have European relevance, i.e. that concern cross border issues, formally within ACER. The so-called Network Codes, aimed at creating a common framework of rules for the management of cross-border interconnections and trade (Jevnaker 2015), represent one of ACER's most important deliverables.

The national dimension of regulation, however, is just as important. Regulators monitor the companies that are active in their national markets for compliance with the national and European regulatory framework. Regulators have to prevent or curb companies' abuses, incentivise them to be more efficient and to pass the efficiency gains on to consumers in terms of lower prices (Pérez-Arriaga 2014).

If the regulatory authority is scarcely resourced, fulfilling these tasks will prove extremely challenging. If a company successfully games the regulator (for the well-known problem of information asymmetry between regulators and regulatees, see Coen (2005)), and prevents market entry by competitors, the goals of liberalisation and competition are hampered. Hence, it is important (and mandated in the relevant European legislation) that regulators possess adequate resources, powers and independence to steer the behaviour of regulatees.

More broadly, the reputation and the legitimacy of regulators hinge on their ability to make good decisions (Leaver 2009). If regulators prove unable to adequately perform their functions, they may face termination or government intervention (Pollack 2002). The argument of this

paper is that, by relying on their network of peers, regulators can improve their expertise, resulting in sound regulatory decisions and a stronger reputation. For instance, they may ask their peers about their experiences with a particular regulatory measure, or how to tackle a specific issue. Moreover, the network allows regulators to benchmark the state of their national market as well as of their own regulatory decisions and practices.

Within regulatory networks, some nodes (i.e. network members) muster more influence than others. This is due to their higher levels of expertise (Papadopoulos 2017) and is presumably connected to the maturity of their market (Maggetti 2014). Thus far, the few contributions on regulatory networks relying on network data have linked the possession of many ties to network influence, in line with the tenets of network theory. They have concluded that regulators having high degree (i.e. a higher number of ties) compared to their peers are influential (Ingold, Varone, and Stokman 2013; Maggetti and Gilardi 2011). These contributions have examined ties as undirected.

Yet, the directionality of ties is as informative as their number: being at the receiving end of many ties may indicate influence, while sending many outward ties indicates activism (Desmarais and Cranmer 2012). The literature has conflated the two analytically distinct concepts of influence and activism, concluding that influential regulators are also active networkers (Maggetti 2014). This contribution assesses activism not in terms of the absolute number of ties, but in terms of the number of outgoing ties that exceed the regulators' strongest (i.e. mutual) relationships, as this indicates effort to gather information from the network.

In his seminal contribution on the strength of the so-called 'weak' ties, Granovetter (1973) showed that the vast majority of his interviewees had found their job thanks to information received from friends of their friends, with whom they had less frequent contact. In that article and in the literature it spawned, 'weak ties' have been shown to play a crucial role in

information diffusion across networks (Djelic 2004). In Granovetter (1973), respondents reached out to their infrequent ties in the pursuit of (in that case, job-related) information. Information is the main asset regulators pursue; given resource scarcity, they may pursue it via other means. Networking with their more resourced peers appears a particularly suitable and relatively inexpensive strategy.

In social surveys, respondents are typically asked to nominate their contacts according to the frequency of their interactions. The absence of reciprocity suggests a weaker relation than would be inferred from reciprocal nominations. In the context of this inquiry, the absence of reciprocity between two regulators indicates different assessments of the frequency of their relationship. I operationalise network activism as the difference between a regulator's outgoing and incoming non-reciprocal ties. A count equal to zero suggests that the regulator sticks to their strongest ties. A regulatory authority can have many mutual ties; this, however, would imply possession of sufficient resources to support a broad portfolio of regular contacts. The interest of this analysis is capturing whether regulators with lower resources are more active than their resources would lead to expect.

A negative count suggests influence (i.e. the fact of being sought by others more than one seeks them). In contrast, a positive count suggests activism, i.e. that the regulator considers relatively weaker ties as important resources of information and advice. Hence, I understand the presence of non-reciprocal ties as indicating an effort, on the part of the sender of the tie, to peruse their environment for more information than the one available within the set of their strong ties.

I formulate the hypothesis that this effort stems from lack of sufficient resources to carry out their regulatory tasks. However, maintaining network ties entails costs, besides benefits (Jackson 2008). Regulators with very low resources may find the expenditure of staff time

devoted to networking to be prohibitively expensive**.** By the same token, well-resourced regulators are unlikely to have many non-reciprocated outgoing ties; since they possess ample in-house expertise, they will not need to cast their network wide to fill their information gaps. Regulators with intermediate levels of resources stand to benefit the most from networking with peers: they possess lower resources than needed, but are not overly constrained. Therefore, the main hypothesis underlying this analysis is:

H1: Regulators with intermediate levels of resources are likely to display higher network activism than regulators with very high or very low resources.

As mentioned, the topic of regulatory independence has been widely discussed in the literature (Danielsen and Yesilkagit 2014; Monti 2014; Ruffing 2014). Several contributions have shown that networks provide regulators with information, that is not available to their domestic political principals; this expands the regulators' autonomy, who exploit their intermediary position between levels of governance (Bach and Ruffing 2013; Ruffing 2014). The relationship between the independence of a regulator and their network behaviour has, however, not been investigated. Arguably, independence may affect network activism in a similar way as resources. A very constrained regulator may find less value in regulatory networking than a regulator at intermediate levels of independence, who may conceivably implement regulatory solutions autonomously. Therefore, I include an indicator of independence in the analysis. The indicator, however, refers to regulators' statutory, or *de jure* independence, which may differ from actual independence (Maggetti 2007) but has been found to be positively correlated to it (Hanretty 2010).

Furthermore, the extent of market liberalisation in the regulator's country may also affect their network activism. The European energy market model is premised on liberalisation and the introduction of private capital in the sector (Thatcher 2007; Jamasb and Pollitt 2005). Hence,

regulators overseeing less liberalized markets may seek interaction with peers overseeing more liberalized markets as they attempt to foster liberalisation in their own national settings. Here, too, regulators overseeing uncompetitive markets may find less value in networking than those whose markets display intermediate levels of competition. For this reason, I also include in the analysis indicators of market liberalisation. Conversely, high levels of independence and market liberalisation should correspond to lower activism.

Finally, I also take into account the extent of electricity and gas interconnections across the EU. The effect of interconnections might be very strong in this network. Regulators on either side of an interconnection have necessarily more opportunity for regular interaction, since flows across countries may cause congestions in their respective national systems and, therefore, costs (Perez-Arriaga 2014). Regular interaction may lead to the development of trust and foster exchange of information. Hence, the network of European energy regulators may, by and large, simply reproduce the network of the interconnected European energy infrastructure, irrespective of resources, independence, and liberalisation.

3. Data, Methods and Analysis.

In order to gather data on regulators' network ties, I contacted the Communication Officers and the Heads of International Affairs departments at national energy regulatory authority from each EU Member State, plus Norway, via email or phone. Not all regulatory authorities have dedicated International Affairs departments, but all have staff dedicated to external relations and communications. Therefore, all respondents have excellent knowledge of their regulatory authority's external cooperation activities. I asked respondents to name the European regulatory authorities that they are most often in touch with as concerns exchange of

information, opinions and advice. I specified that they should mention their most frequent informal contacts, beyond scheduled network meetings or EU-related policy events, and that they should focus on exchanges of information, opinions and advice, beyond routine interaction.

Under promise of anonymity, I obtained replies from all 29 regulatory authorities, bar one. For that one, I considered their incoming ties, resulting from other regulators' nominations, as reciprocated. I did not specify an upper or lower limit to the number of network partners that regulators could name as their most frequent contacts, in order to capture the different extents of individual regulators' ties. Moreover, I also left the precise frequency of contact unspecified. Regulators were asked to report on their 'most frequent' contacts. Clearly, the word 'frequent' may mean different things to different respondents. Also, different regulators may engage more or less often with peers from other countries based on a variety of factors. Then, reciprocity is a first good indicator of the strength of two regulators' relationship. Lack of reciprocity, instead, suggests imbalance in the two regulators' assessment of the frequency of the relationship and, therefore, a weaker one.

Yet, the sender of a non-reciprocal tie, by the very fact of mentioning the tie in response to my question, indicates that they assess that relationship as important. Possession of non-reciprocated outgoing ties operationalises a more pronounced network activism compared to regulators who only engage in mutual relationships (an activism of zero according to my operationalization) or display negative values, suggesting that information is sought from them more than they seek information from others.

While I gathered original data on European national energy regulators' ties, I rely on secondary data concerning their resources[i]: the report on national regulatory authorities' staff resources

released by ACER in 2016[ii]. The ACER report groups regulators according to the number of Full-Time Equivalent (FTE) staff dedicated to the regulation of energy markets. Therefore, this represents a substantively precise, if numerically less so, measure of the resources each European energy regulatory authority can rely upon in the performance of their primary functions[iii].

The ACER document categorises regulators' staff levels in six categories: 'large' (over 220 FTE); 'medium-large' (between 170 and 175 FTE); 'medium' (between 90 and 140 FTE); 'medium-small' (between 50 and 75 FTE); 'small' (between 12 and 50 FTE) and 'micro' (fewer than 12 FTE). As shown in Table 3 in the online appendix, category 'large' is not significantly different from 'medium-large'. Since the category 'medium-large' only comprises two national regulatory authorities (Italy and Spain), I merge this category into 'large' in order to save degrees of freedom. Thus, the categorisation of staff resources used in the analysis comprises five categories: 'large' (with 9 observations), 'medium' (6 observations), 'medium-small' (6 observations), 'small' (5 observations) and 'micro' (4 observations)[iv].

As for the covariates, I derive data concerning regulators' independence from the Organisation for Economic Cooperation and Development (OECD) Sector Regulators indicators, released in 2015 and referring to the year 2013[v]. The independence indicator is the average of three indicators: the extent to which regulators have to take instructions from the executive in their regulatory practice, their financing arrangements, and their recruitment practices. The OECD data features two separate indicators for independence; one for electricity and one for gas regulation. These are very highly correlated (Pearson's correlation coefficient is .80). Further, I include a measure of market liberalisation from the same OECD dataset (correlation between

electricity and gas is .50). Finally, I use data on electricity and gas interconnections across the EU[vi], to test for their influence on regulators' ties.

To assess the association between resources and network activism, I carry out Analyses of Variance (ANOVA). Thereafter, I run Ordinary Least Squared (OLS) models, including the mentioned covariates for independence and liberalisation, to assess the correlation between resources and activism. Moreover, I assess the relevance of staff resources in explaining the whole structure of informal bilateral ties among European energy regulators, using Exponential Random Graphs Models (ERGMs). ERGMs have been specifically devised to deal with the interdependencies of network data (Cranmer et al. 2017; Robins et al. 2007).

Typically, network data features interdependencies. Regulators are embedded in local network substructures depending on social interaction mechanisms, such as a tendency for the members of social networks to share a tie if they have one connection in common (i.e. the property of transitivity), or the tendency to reciprocate ties (i.e. reciprocity). Hence, their activism (here, the difference between outgoing and incoming non-mutual ties) may derive from network properties, rather than association with the independent variables. Therefore, in addition to linear regressions, I run ERGM models, which, besides staff data and the covariates, include dependencies for reciprocity, activity (the possession of many outgoing ties) and transitivity.

Analysis.

The online appendix contains figures and tables showing the relationship between staff levels and activism: figure 1 shows that regulators with medium or small resource levels appear more likely to be active networkers compared to their counterparts; figures 2 and 3 outline the

relationship between the dependent variable and regulatory independence and market liberalisation, respectively, in electricity and gas. In both sectors, the linear relationship has a negative slope (dotted black line). However, regulators with medium resources seem more active as liberalisation increases. Regulators at intermediate levels of independence also appear more active, suggesting a quadratic relationship.

Table 4 and Table 5 in the online appendix report the results of OLS models testing the association between staff levels and network activism along with the covariates. All variables have been normalized to have mean 0 and a standard deviation of 1. The regressions describe the data well, considering the small number of data points. Whereas the results for independence confirm expectations (the relationship is concave and significant), those for liberalisation do not. The interaction between liberalisation and resources shows (more clearly so in electricity) that regulators with medium resources have higher activism at higher levels of liberalisation.

When answering my question about their contacts, regulators provided qualitative evidence of their usage of the network. A regulator from an authority with low resources (category 'small') commented:

> *We have excellent relations with all but, particularly for questions of regulatory practice, we refer to the big ones, you know, Italy, Germany, France, also the UK, because they have more expertise.*

A regulator from an authority with large resources commented:

> *Well, we are mostly in touch with other big authorities, those are the ones we have most in common with and benefit most from the exchange. We receive many requests from*

others, and try to answer them all, of course. But generally, we are mostly in touch with other big ones.

Regulators from two different authorities with intermediate resources (categories 'medium' and 'medium-small') commented:

This depends on the topic at hand. In case of general issues, we ask more than one NRA [National Regulatory Authority]. *In case of specific issues, we ask the NRA(s) that seems in our view most suitable. With X we have a more intense relation, due to the fact that we not only share a border but also share similar views on how markets should operate.*

Individual NRAs sometimes send out a group email to others to ask a question about a particular practice or regulatory measure, and many of us reply, but that can be from any one on any issue, so probably not 'indicative' of particular relationships, although it does testify to the usefulness of having a network of regulators. As a personal general 'feeling', X is often consulted, as is Y, because they have lots of information and are also very active. X also has reputation as mature market, so people often read up on their approaches.

The quotations above reveal important information on this regulatory network. Firstly, resources play a major role; secondly, the national and the European dimension of market regulation are entwined, pushing regulators to look for the best-informed peer on any given topic. Thirdly, geography plays a role: regulators from interconnected markets are bound to interact frequently; these 'functional' relationships may evolve into relationships of trust and exchange. Fourthly, regulators from bigger markets tend to interact with other regulators from bigger markets, displaying a pattern of homophily (McPherson, Smith-Lovin, and Cook 2001).

Fifthly, market maturity seems to matter. Finally, regulators who are active networkers are also more sought after, as they possess more information.

On this background, I run ERGMs including the above-mentioned explanatory variables and network dependencies. Results are in Table 1.

Table 1 - ERGM of the network of European energy regulators

	Model 1	Model 2	Model 3
Density	-5.86***	-5.85***	-8.52***
	(0.50)	(0.54)	(1.26)
Homophily for resources			
Large	1.10**	1.02**	1.03**
	(0.34)	(0.34)	(0.34)
Medium	-0.37	-0.15	-0.21
	(0.47)	(0.46)	(0.46)
Small	0.33	0.28	0.35
	(0.46)	(0.47)	(0.48)
Micro	0.83		0.52
	(0.94)		(0.79)
Resources and outgoing ties			
Large	reference		
Medium	1.28**	1.11**	1.43***
	(0.42)	(0.43)	(0.41)
Medium-small	0.30	0.35	0.21
	(0.49)	(0.48)	(0.52)
Small	0.77	0.73	0.56
	(0.43)	(0.45)	(0.45)
Micro	0.16	0.38	-0.12
	(0.65)	(0.65)	(0.69)
Liberalisation and incoming ties (electricity)			
Liberalisation (indicator)	0.17	0.17	
	(0.12)	(0.14)	
Liberalisation (high)			reference
Liberalisation (medium)			0.56*
			(0.24)
Liberalisation (low)			0.14
			(0.26)
Liberalisation (very low)			0.25
			(0.50)
Liberalisation and outgoing ties (gas)			
Liberalisation (indicator)		0.02	
		(0.11)	
Independence and outgoing ties (electricity)			
Independence (indicator)	0.08	0.18	
	(0.20)	(0.10)	
Independence (high)			1.01
			(0.88)
Independence (medium)			1.28*

			(0.60)
Independence (low)			0.44
			(0.64)
Independence (very low)			reference
Independence and outgoing ties (gas)			
Independence (indicator)	-0.19	-0.26*	
	(0.20)	(0.12)	
Independence (high)			reference
Independence (medium)			1.69
			(1.04)
Independence (low)			1.91
			(1.02)
Independence (very low)			2.65*
			(1.20)
Interconnections			
Electricity interconnections	1.22***	1.29***	1.27***
	(0.23)	(0.23)	(0.22)
Gas interconnections	0.00	-0.01	0.03
	(0.09)	(0.10)	(0.09)
Interdependencies			
Reciprocity	2.61***	2.54***	2.64***
	(0.37)	(0.39)	(0.37)
Activity	5.56*	4.80*	5.66*
	(2.25)	(2.01)	(2.26)
Shared partners	0.02	0.01	-0.01
	(0.03)	(0.04)	(0.04)
Transitivity	1.24***	1.30***	1.29***
	(0.20)	(0.22)	(0.20)
AIC	497.19	462.57	492.58
BIC	581.78	544.54	605.37
Log Likelihood	-230.59	-213.28	-222.29
	***p < 0.001, **p < 0.01, *p < 0.05		

The results of ERGMs should be interpreted as those of logit models, i.e. as indicating the odds of a given outcome to occur. The outcome is the presence of a tie between any two nodes of the network. It must be noted that, in ERGMs, the dependent variable is the network itself. Specifically, ERGMs assess the likelihood that the observed network structure could have been

generated by the factors included in the model. The models in Table 1 corroborate my hypotheses concerning the drivers of network activism.

Model 1 refers to the whole network. Model 2 refers to the network excluding two countries that do not have gas. These models, while confirming the main hypothesis, do not show any significant effect of independence and liberalisation. Hence, in model 3, which again includes all regulators, I use transformed categorical data for independence and liberalisation (see Figure 5 in the online appendix). Indeed, if the relationship is non-linear (as the OLS suggest) and there are few data points, categorising quantitative variables may be appropriate, particularly if they reflect meaningful qualitative differences. Model 3 corroborates the results of the OLS: regulators with intermediate independence seem to be more active compared to others. Model 3 displays the best fit (see online appendix for Goodness of Fit plots).

Table 1 also confirms the homophily pattern suggested by the qualitative evidence: regulators with large resources network most with each other. Regulators with medium-small resources are excluded from the homophily count as they do not have ties to each other, hence their coefficient cannot be calculated. Once countries without gas are excluded, the same happens to regulators with micro resources, as per model 2.

The structure of the interconnections across EU Member States matters for explaining regulators' ties. As expected, the coefficients are only significant for electricity interconnections, not for gas interconnections: having to manage electricity cross border congestion increases the odds of frequent communication. This result helps explaining the scarce activism of regulators with 'medium-small' resources: these are regulators from countries in the geographic periphery of the EU (see table 2 in the online appendix). They have few neighbours, and few ties overall. This shows that network structure and, arguably, activism, also depends on geographic position.

Dependencies show that the ties in this network are likely to be reciprocated and that triangles tend to be closed (i.e. transitivity). Moreover, some regulators are significantly more active than others and send many outgoing ties (i.e. the coefficient for activity). Overall, if two regulators share a connection, or an electricity interconnection**,** they have higher odds of being connected than otherwise. If either has intermediate levels of staff, this further increases the odds of tie existence.

4. Discussion of the results.

The results of the analysis lend support to the hypothesised mechanisms and show that regulators with medium levels of staff resources tend to have more non-reciprocated ties, and more outgoing ties overall. However, regulators with small staff resources do not, suggesting that they are so resource-constrained as to be unable to compensate via networking.

Regression and ERGMs suggest that regulators are most active at intermediate levels of independence. As for liberalisation, it dampens activism; when interacted with resources, however, it increases activism for regulators with medium resources. These results suggest that regulators network whenever the benefits outweigh the costs. Constrained regulators derive lower value from their peers' insight and will therefore network less beyond their set of reciprocal ties.

This analysis is limited by the small size of the data and by the usage of indicators, which, in the case of independence, refer to statutory provisions that may not always reflect reality. Liberalisation indicators are based on percentages of public ownership and measures of vertical integration in the markets. I conducted further analyses with the separate components of both

indicators (available upon request). The significant association between staff resources and activism remains across all specifications.

Overall, these results suggest that the effect of regulatory networks on European governance may be indirect, and pass through the improvement of regulators' expertise and national regulatory practice. The scope of European national regulators' authority is confined to the borders of their country. Steeped in very different institutional contexts, regulators need to overcome or reduce information asymmetries with the regulated industry (Pérez-Arriaga 2014). This analysis suggests that, when faced with lower resources than needed, regulators tackle the demands of their profession by relying on the experience and expertise of their peers. They do so provided that staff resources are not as low as to make networking prohibitively expensive, and that they enjoy sufficient independence to implement regulatory solutions.

The patterns emerging from this analysis may well be valid for networks beyond the energy sector. Possession of adequate human resources is absolutely key to good regulatory performance (Glachant et al. 2013; Domah, Pollitt, and Stern 2002). However, the importance of the geographic element in fostering ties across regulators is plausibly prevalent primarily in infrastructure regulation.

Therefore, our understanding of the potential of transnational regulatory networks to improve governance should transcend the transnational or global governance perspectives and assess governance improvements at national level. Access to informed and resourced peers may improve the problem-solving and analytical capacities of regulatory authorities (Lodge and Wegrich 2014) at national level, despite barriers to transnational regulatory convergence.

5. Conclusions.

Although underlining the importance of networks for information exchange among regulators, the literature has failed to specify the mechanisms whereby regulators network for expertise. This paper makes a step in that direction using original data on European energy regulators' ties to each other (gathered under promise of anonymity) and secondary data on their resources.

The analysis assesses the relationship between regulators' network activism, operationalised as the number of their non-reciprocal outgoing ties, and the extent of their resources, operationalised as staff levels. Possession of non-reciprocal ties suggests that the regulatory authority branches out beyond their closest contacts in pursuit of information, much like job-seekers contacted the friends of their friends in the seminal Granovetter's (1973) article on the strength of weak ties for information diffusion.

To fulfil their tasks, regulators rely on expertise and information. Resource-constrained regulators are less able to acquire both (Glachant et al. 2013) and therefore less able to set the right incentives for regulated industries, or recognize and sanction their wrongdoings. Staff levels have been found to correlate with higher quality regulation (Koop and Hanretty 2017). The hypothesis guiding this analysis is that regulators with intermediate levels of resources are more active networkers because they use their informal networks to compensate for the missing resources. The results lend support to the hypothesis. A model of network structure confirms that regulators with medium levels of resources are more active overall, taking into account their position, their independence, and network interdependencies.

This analysis suggests that regulatory networks have a formal (European) and an informal (bilateral) dimension. The national and European dimensions of regulation are entwined.

Separating them for analytical purposes, however, is useful to obtain a clearer picture of the purposes of regulatory networking.

The formal dimension has been widely studied: regulators meet regularly, achieve joint positions on matters of European relevance, and put those forward to the European Commission, while attempting to implement them in their national markets. This study focuses on the informal dimension: regulators maintain several bilateral informal relationships, affording them direct and timely access to the repository of high quality information constituted by their peers. This repository is useful when seeking professional opinions, assessing the consequences of a regulatory decision, or benchmarking regulated entities against European best practice. Not all regulators, however, make the same use of the network. This paper shows that regulators with medium resources are the most active networkers, as they are able to benefit most from the exchange.

The benefits of transnational collaboration may improve European regulatory governance from the backdoor of national regulatory practice, providing for more informed regulators than it would have been possible on the basis of domestic resources alone. Analyses assessing the effect of information and/or expert advice received through informal network ties on regulatory decision-making would represent a suitable follow-up to this analysis. An important limitation of this analysis is that it does not assess the quality of the human resources possessed by regulatory institutions. This is a promising task for future research.

A final word needs to concern the availability of data on national regulatory authority's resources: gathering this data is exceedingly difficult, as no central platform appears to collect it on a regular basis and make it publicly available. National reports often do not contain this information. As a result, research using this data has to rely on imprecise or slightly outdated data. Making this type of information more readily available to the scientific community would

not only improve research on regulatory networks, but also corroborate demands for adequate resources to be provided to national regulatory authorities.

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[i] Ideally, I should have been able to gather these data from the annual reports of regulatory authorities. However, only very few regulatory authorities regularly provide these pieces of information in their annual reports, which are often not produced in English. Moreover, multi-sectoral regulatory authorities rarely provide figures for staff working on energy regulation, which is problematic.

[ii] ACER Taking stock of the regulators' human resources - Summary of findings (2016), https://bit.ly/2GQnzFP (last accessed 9 April 2018). I complement this source with the country reports released by the European Commission in 2014 - 'EU Energy Markets in 2014', https://bit.ly/1H9UhwP (last accessed 9 April 2018) - The country reports contain budgetary and staff figures referring to the year 2013, provided by national regulatory authorities. As with the annual reports, however, multi-sectoral regulatory authorities provided figures comprising all staff, rather than those relative to energy regulation. Further, budgetary figures are provided in Euros also for countries that are outside of the Euro area. It is impossible to discern what criterion was followed in translating these figures into Euros. Hence, I only used these reports to check for highly noticeable discrepancies with the ACER document. I did not find any.

[iii] Intuitively, budgetary and staff figures are strongly correlated. Indeed, according to the (continuous) figures in the European Commission reports, the Pearson's correlation coefficient between budgets and staff is 0.73.

[iv] In other analyses, I split regulators in the 'medium-small' category between group 'medium' and group 'small' on the basis of their staff figures in 2013 (derived from the European Commission country reports). The results do not significantly change.

[v] OECD, (2015), Indicators of Sectoral Regulation, https://bit.ly/2mb4EwM (last accessed 9 April 2018).

[vi] Data on electricity and gas interconnections consist of a matrix reporting electricity flows in both directions across EU Member States in GWh in 2015 (data from ENTSO-E website, https://bit.ly/2L7rXWt - last accessed 22 April 2018) and a matrix reporting gas flows in both directions across EU Member States in cubic meters of gas in 2015 (data from UK government website https://bit.ly/2jEWqtR - last accessed 22 April 2018).

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